Climate Science in the Public Interest

Climate Change Impacts on Snowpack and Water Supply in Washington State

Matthew Wiley
Richard Palmer
University of Washington ,
Department of Civil and Environmental Engineering

Featuring:
Andre Ball, James Battin, Margaret Hahn, Alan Hamlet, Elizabeth Korb, Philip Mote, Mary Ruckelshaus

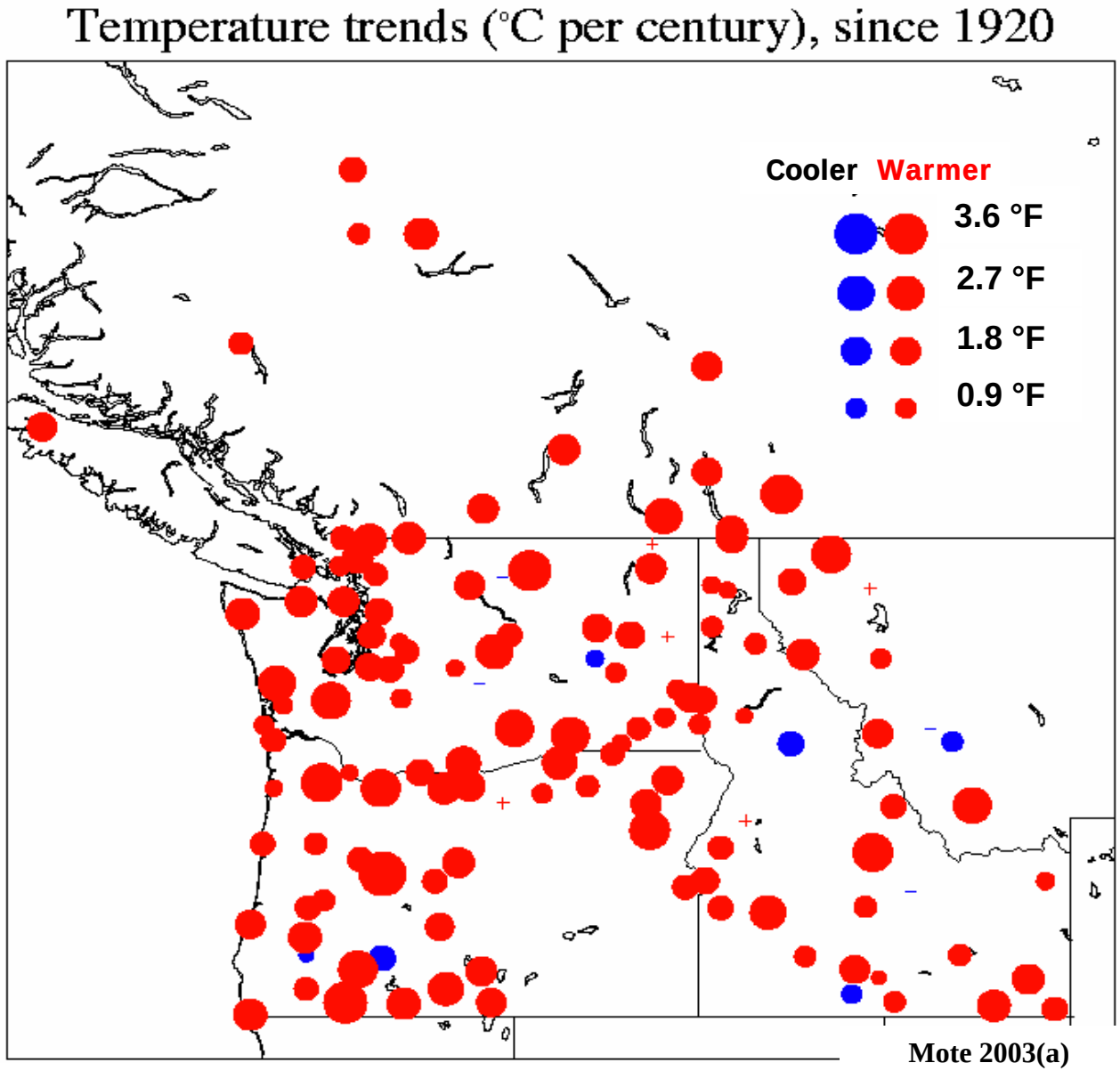
Overview

- Climate change impacts on water resources can already be seen in the historic record
- Projected future changes will be significant
- Climate change can further complicate existing resource allocation decisions
- Climate change is uncertain, but not so much that it is not possible to incorporate it into the planning process.

What has already happened

Temperature Trends by Station

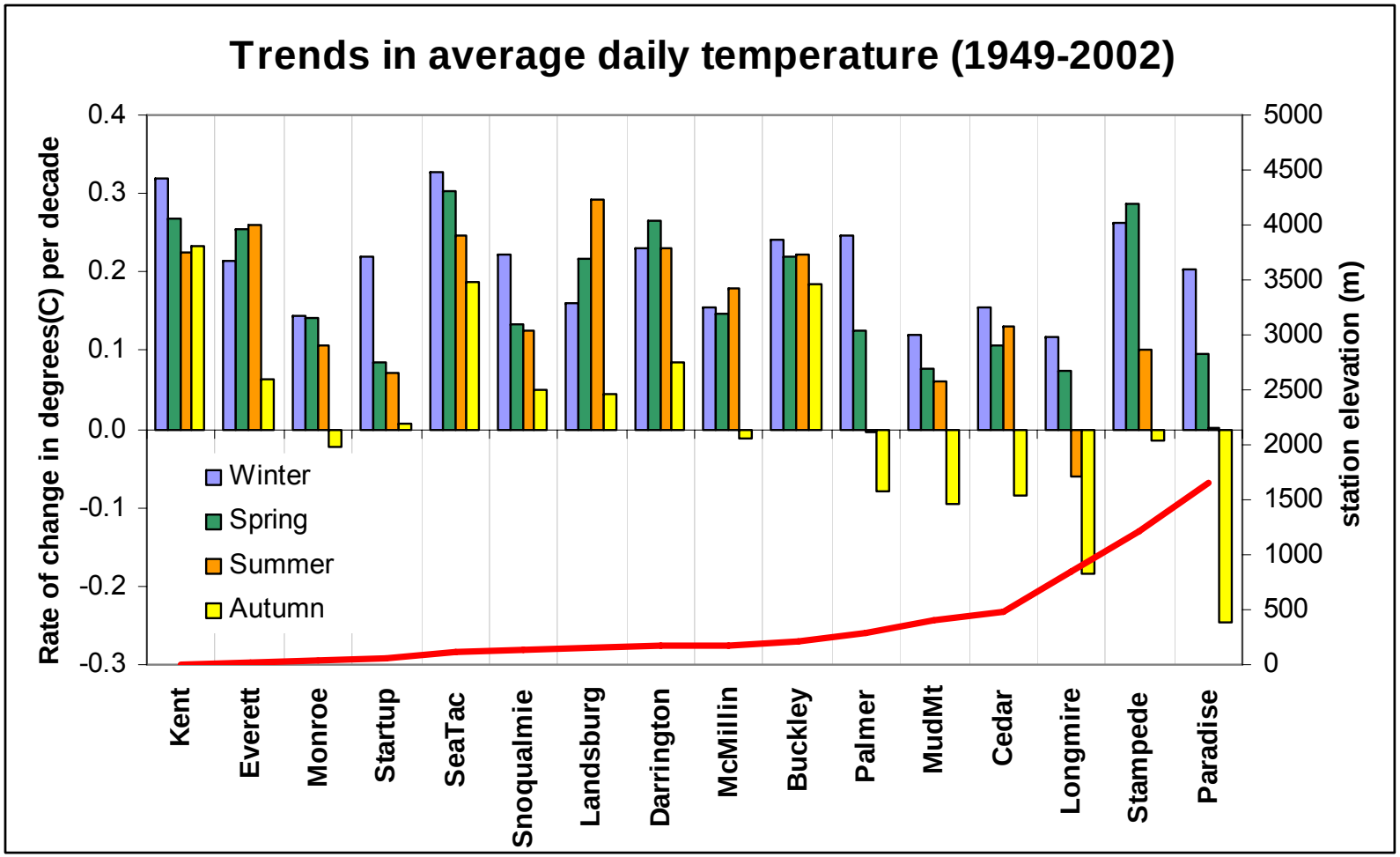
- 154 stations with long records
- Almost every station shows **warming**
- Urbanization **not** a major source of warming



Mote 2003(a)

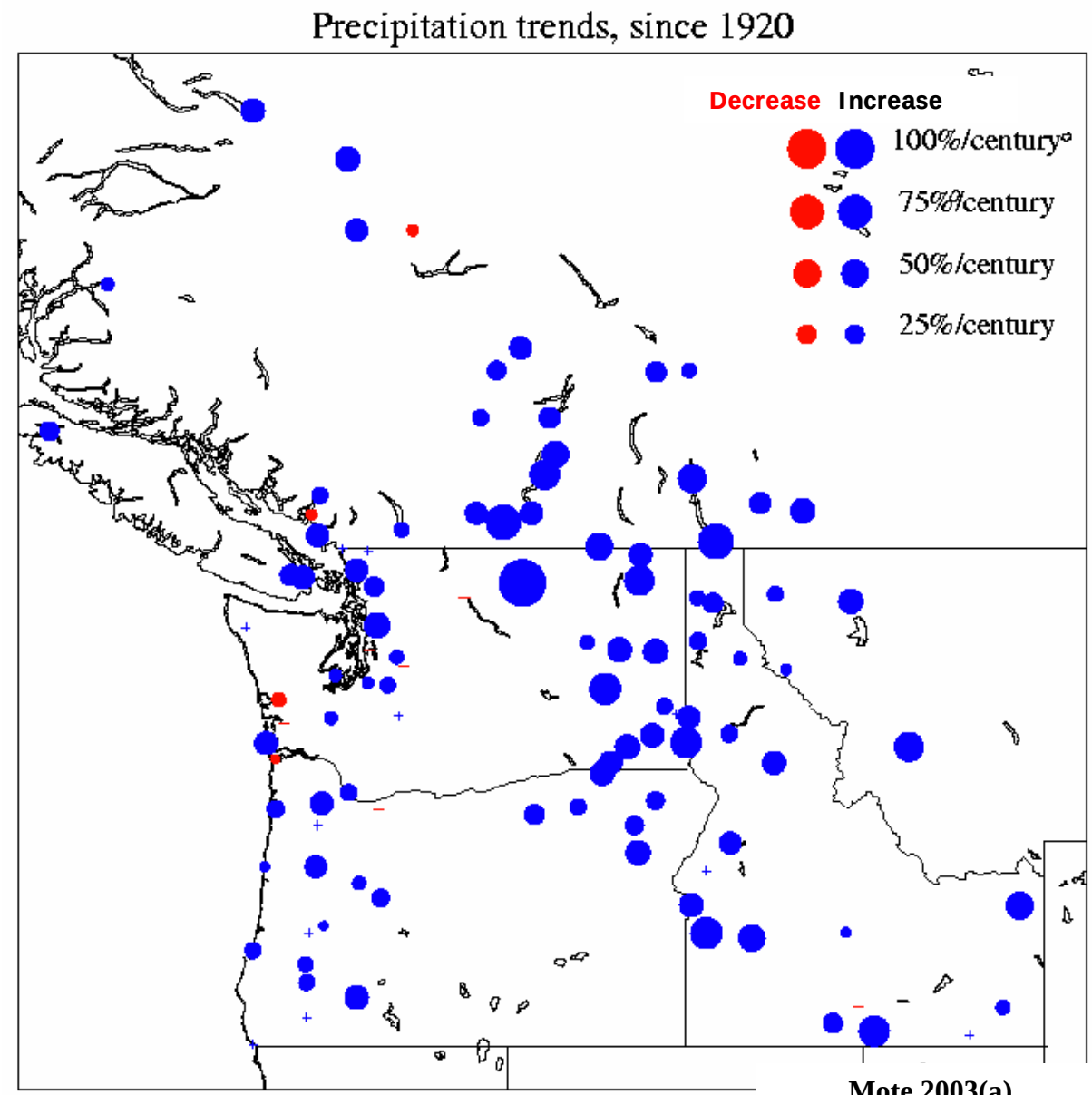
Evidence of Climate Change

Seasonal trends – by station



Precipitation Trends by Station

- 165 stations with long records
- Most stations becoming wetter – **average increase of 2.9 inches (14%)…**
- …however, it is more difficult to assess trends due to challenges in measuring precipitation



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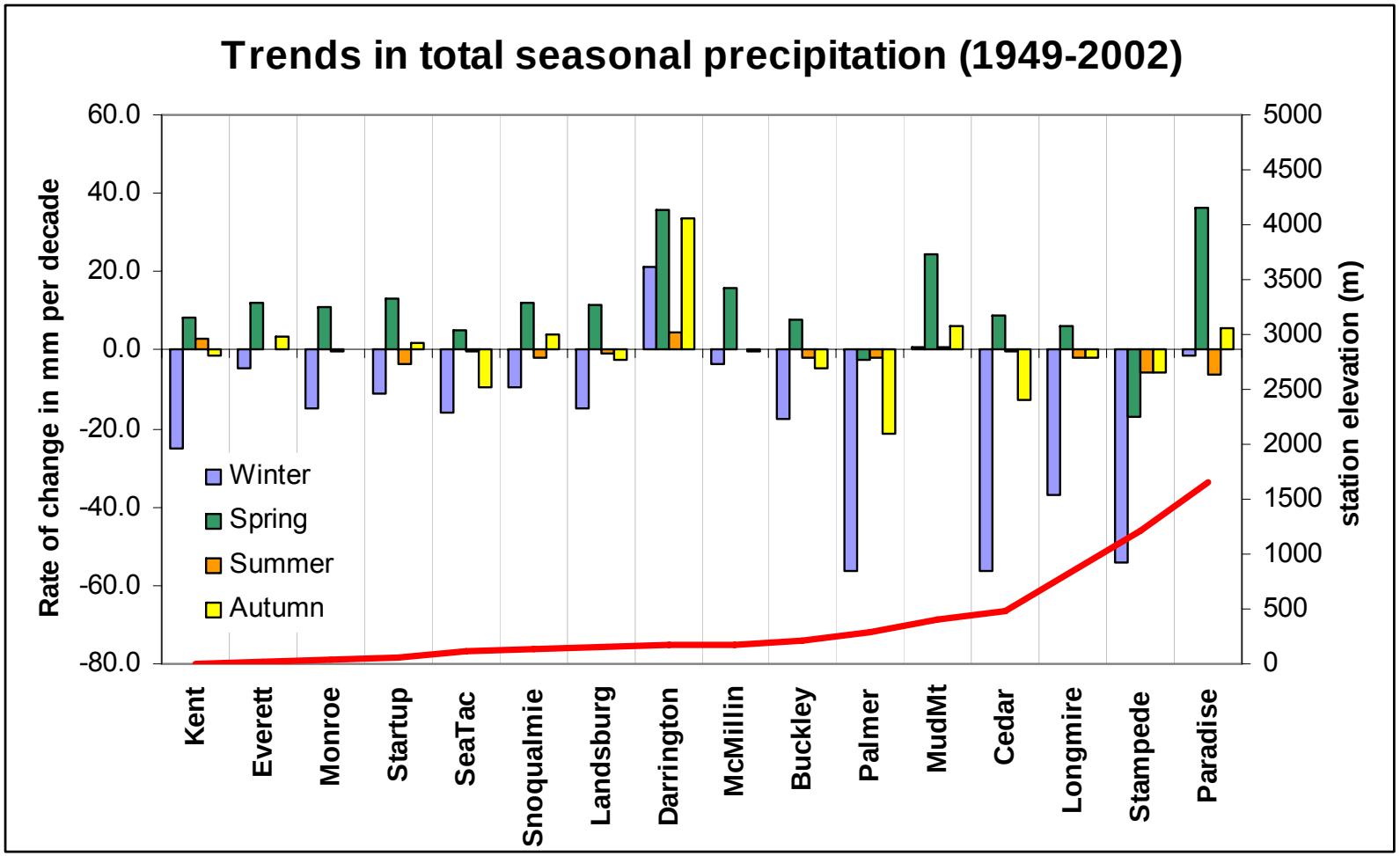
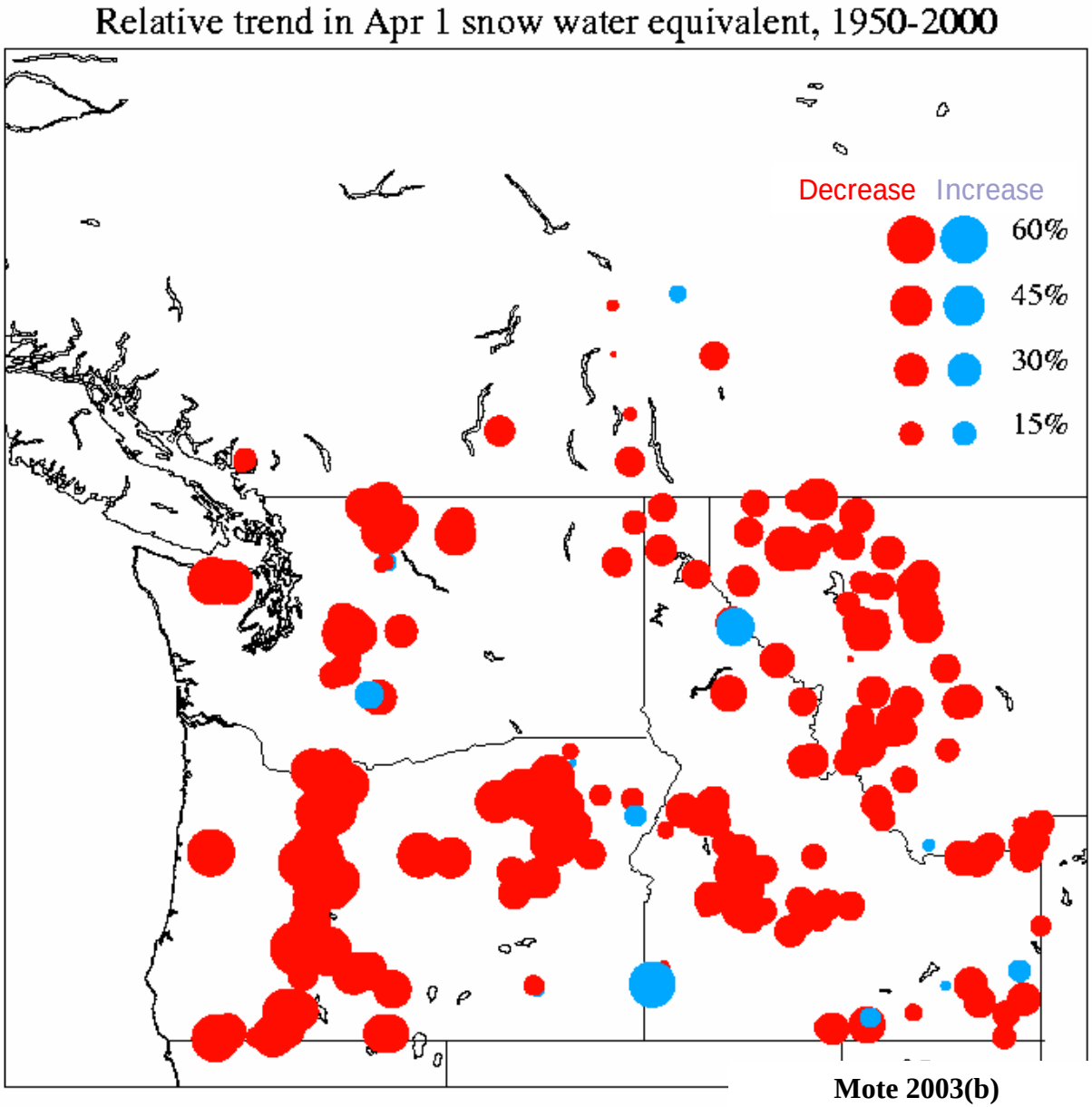


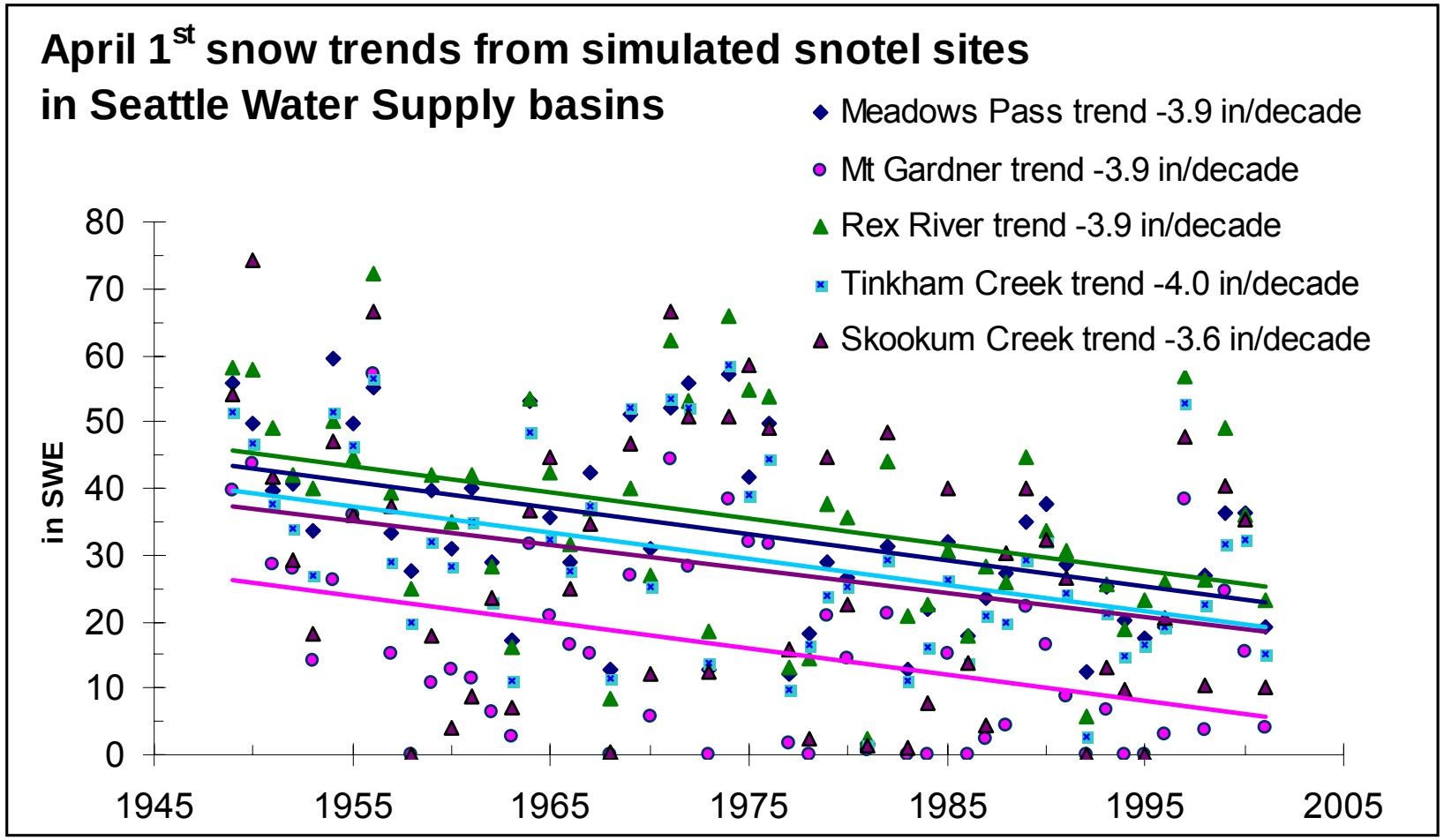
Snow Water Equivalent Trends

- Results based on data from 260 snow course collection sites
- Most stations showing a **decline in snow water equivalent**
- Numerous sites in the Cascades with 30% to 60% declines



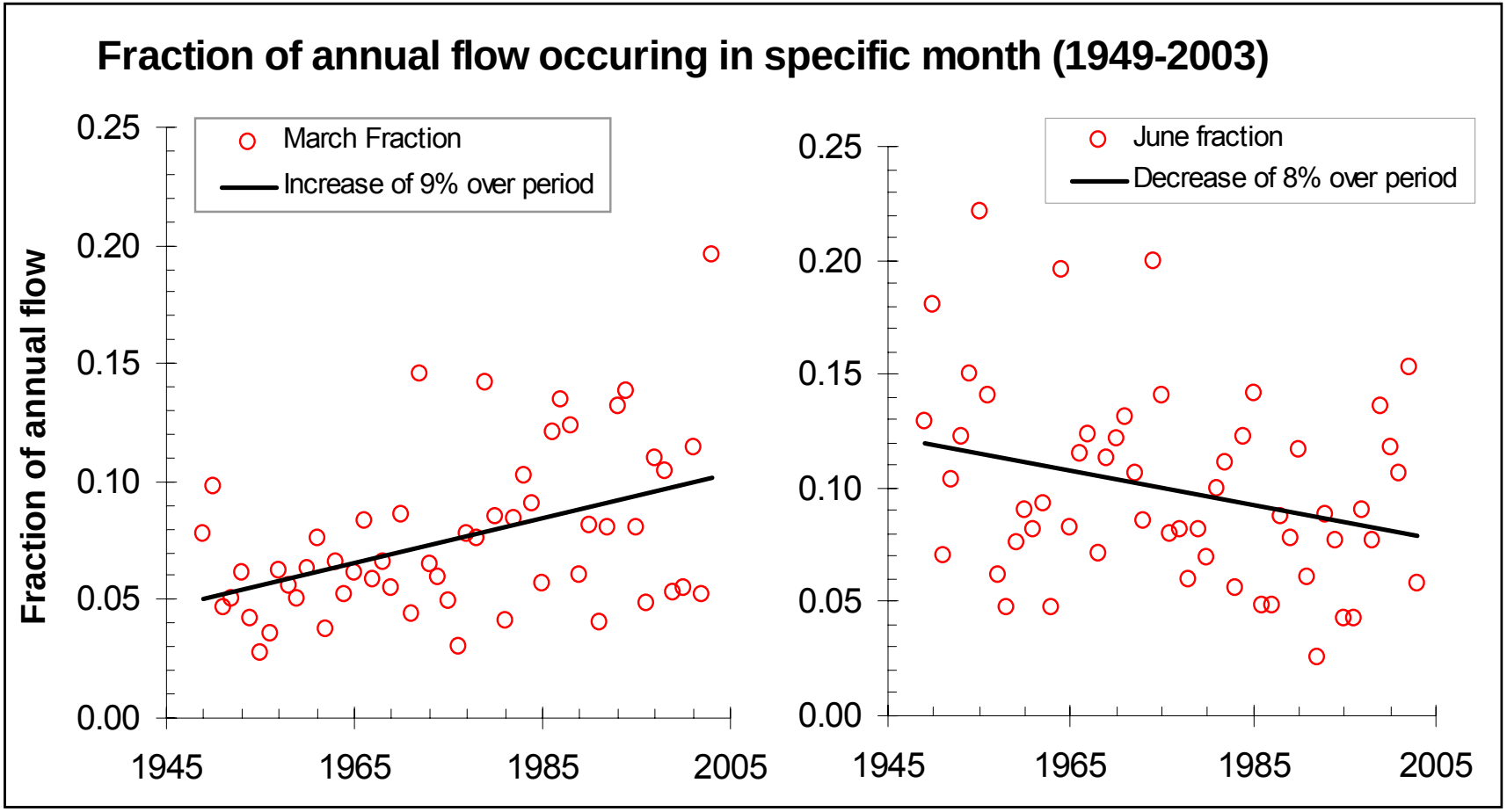
Mote 2003(b)

April 1 SWE Trends (Simulated) in Seattle Water Supply Basins



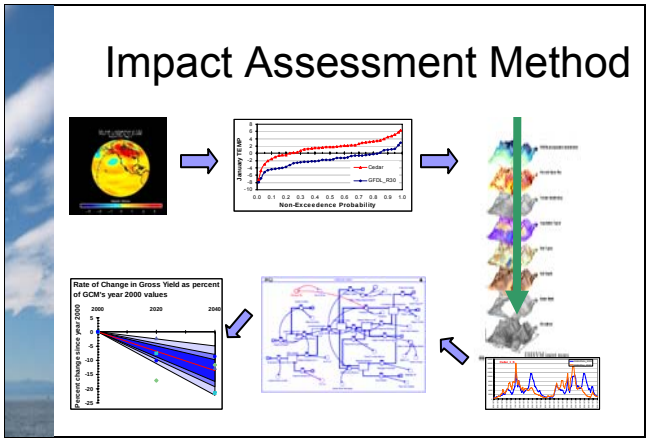
Declining trends also seen in other Cascade Snotel sites

Changes in Annual Spring Flow on the Cedar River above Chester Morse Resv.



Fractions of annual flow occurring in March and June on the Cedar River above Chester Morse reservoir. Station Elevation 1560 ft.

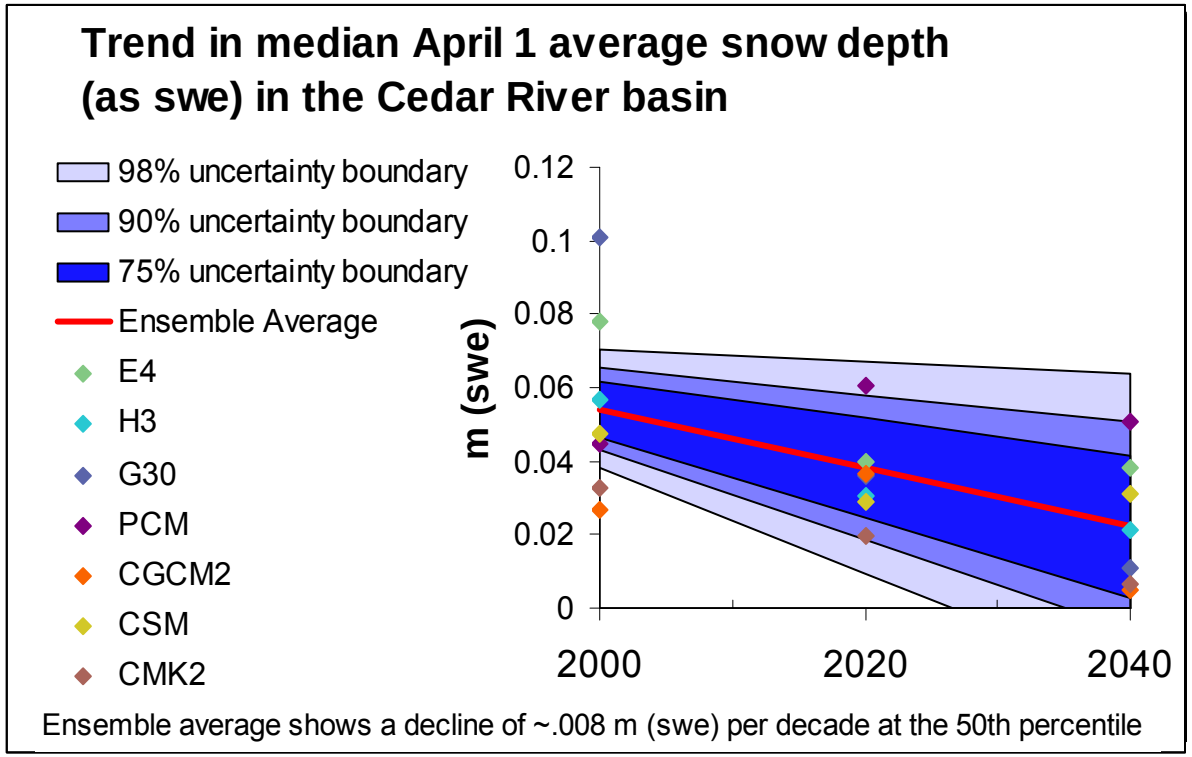
What is predicted to happen



Impacts of Climate Change

Snowpack – Cedar and S.F.Tolt basins

- Average annual maximum seen to decrease by as much as 50% by 2040.
- Timing of peak shifts earlier in year.
- Extreme event more common.
- Uncertainty in trends

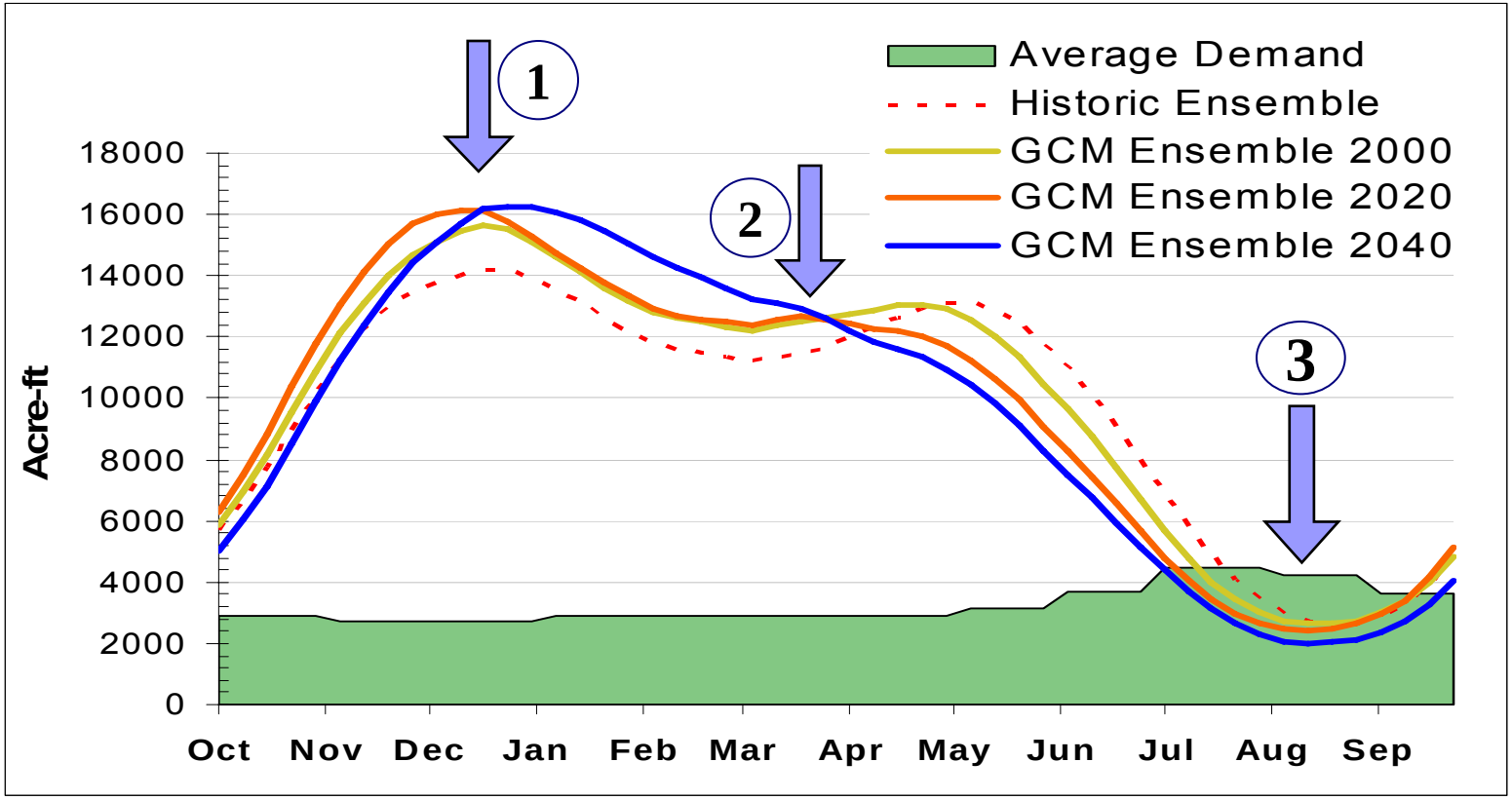


Median April 1st Snow Pack for Snohomish Basin

HadCm3 yr 2050

These changes contribute to…

1. Higher winter flows (incr. winter flood risk)
2. Earlier and lower peak flows (longer dry season, less water for salmon)
3. Lower summer flows, and warmer stream temperatures

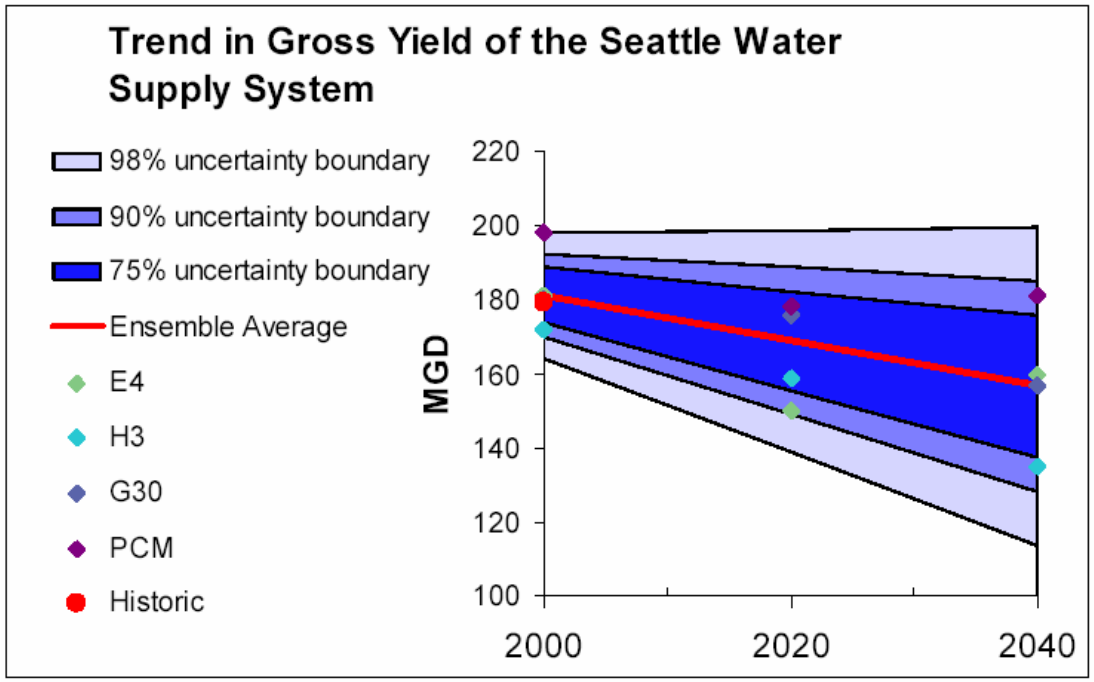


Projected Climate Change Impacts on Inflows to Seattle's reservoirs

Impacts of Climate Change

Gross Yield

- Translating impacts in hydrology to impacts on people → System Yield
- Trend fit to all GCM points shows a decrease of ~6 MGD per decade (~3% per decade)
- Substantial spread in the results from each GCM.



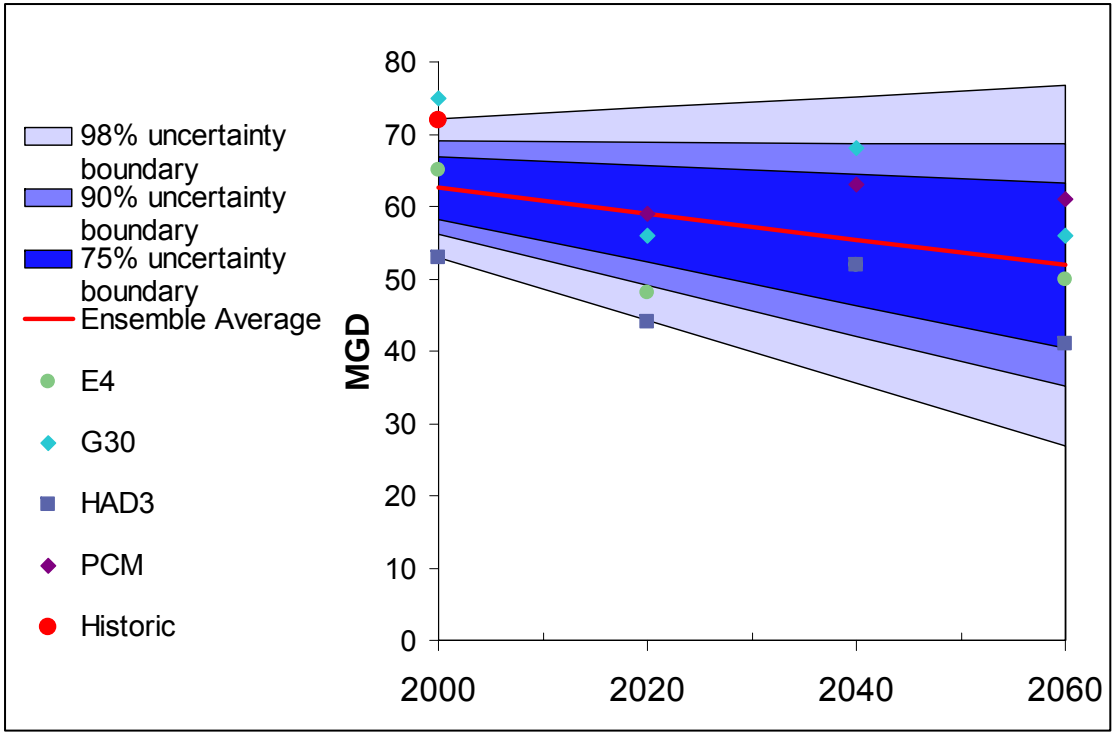
Rate of Change per Decade			
Ensemble Avg	-3.4%		
75% boundary	-2.4%	to	-4.4%
90% boundary	-2.0%	to	-4.8%
98% boundary	-1.2%	to	-5.6%

Wiley, M.W. (2004). "Analysis Techniques to Incorporate Climate Change Information into Seattle's Long Range Water Supply Planning," Master's thesis, University of Washington.

Safe Yield Analysis of Proposed Lake Tapps Water Supply System

- Lake Tapps design capacity 65 MGD
- 1.8 MGD loss per decade trend seen between 2000 and 2060

  (~3% per decade)



Ball, J.A. (2004). "Impacts of Climate Change on the Proposed Lake Tapps-White River Water Supply," Master's thesis, University of Washington.

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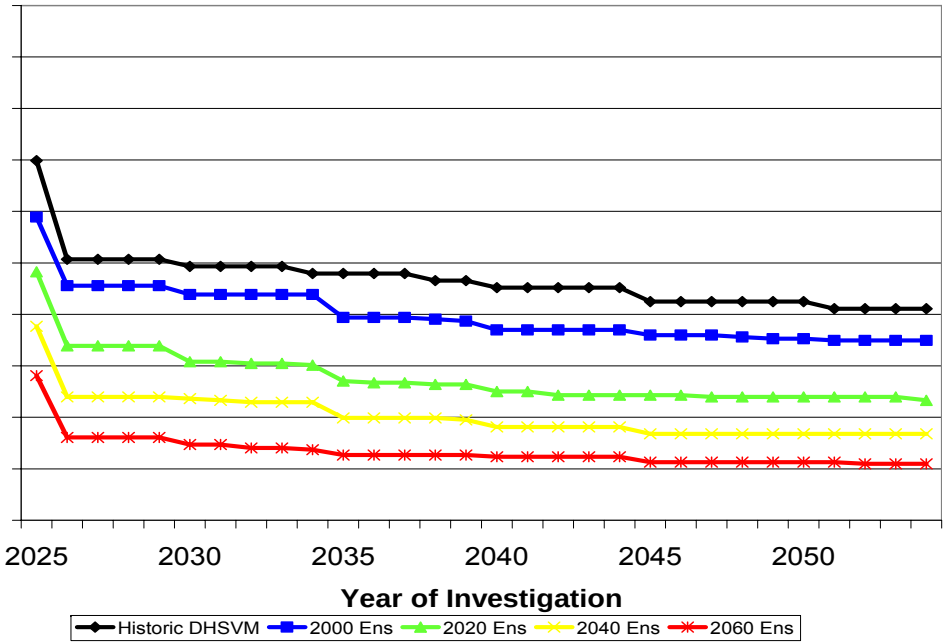


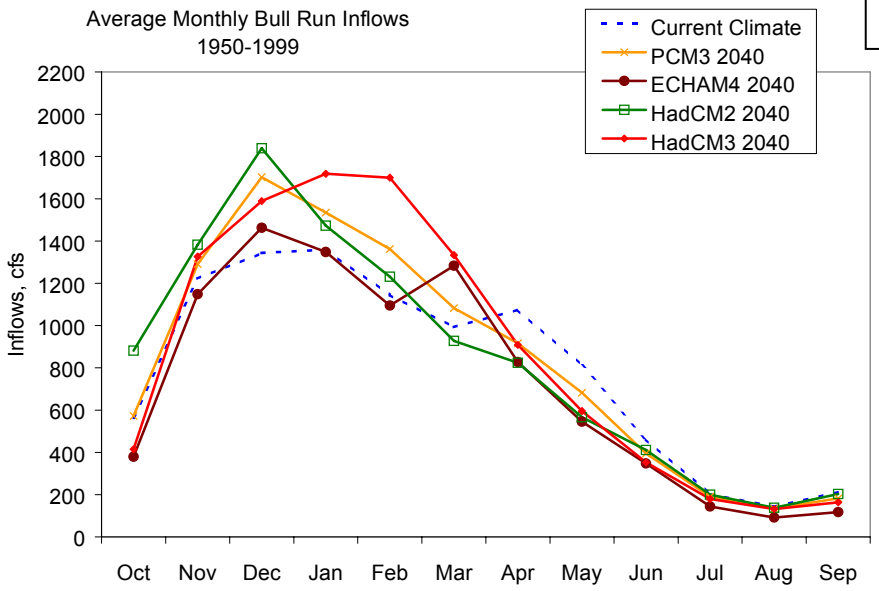
ected annual reliability of recreational lake level

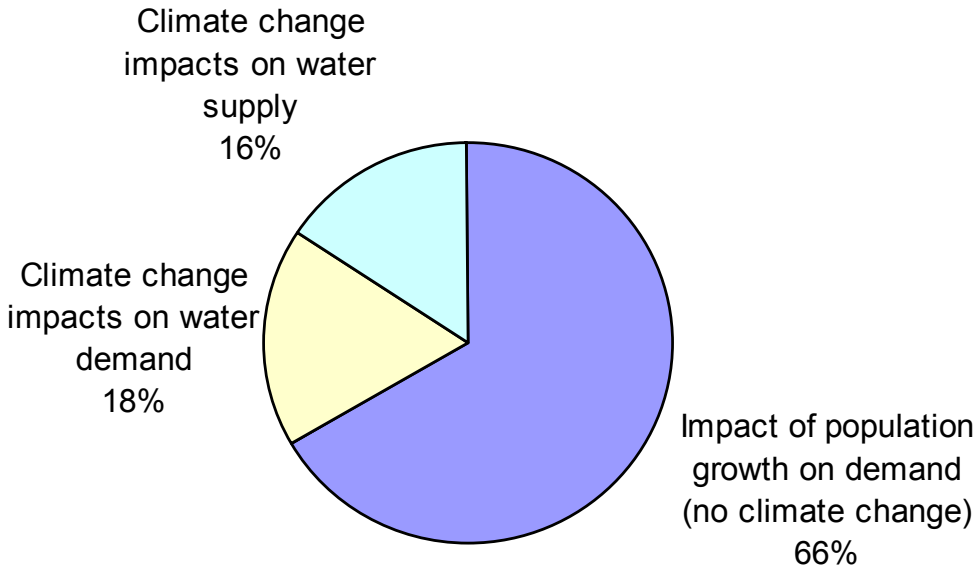
Portland Water Supply

2040s WATER NEEDS IN PORTLAND (OR):

Regional growth: +40 mgd
Climate change: +20 mgd

Climate change impacts = 50% of growth impacts



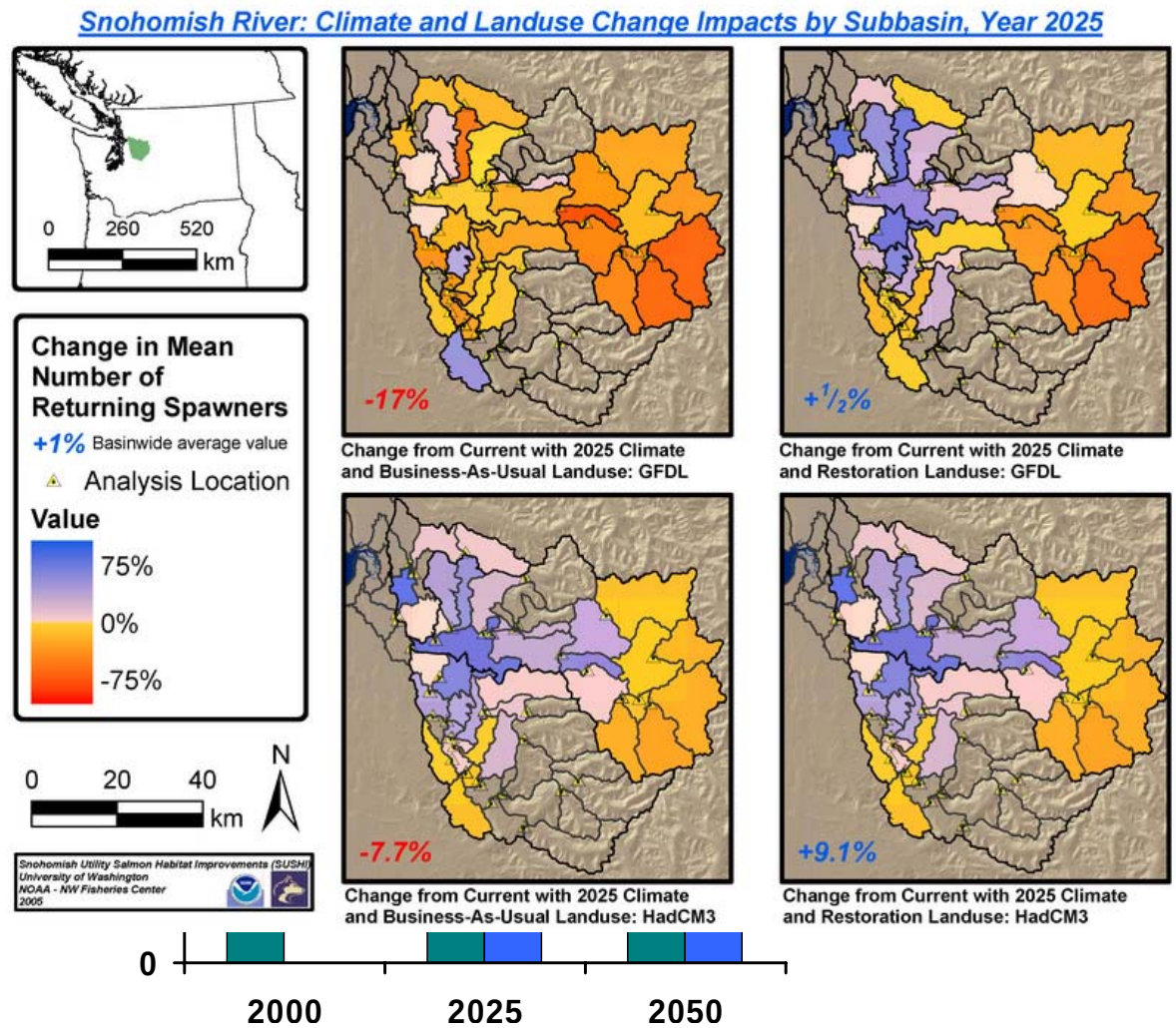


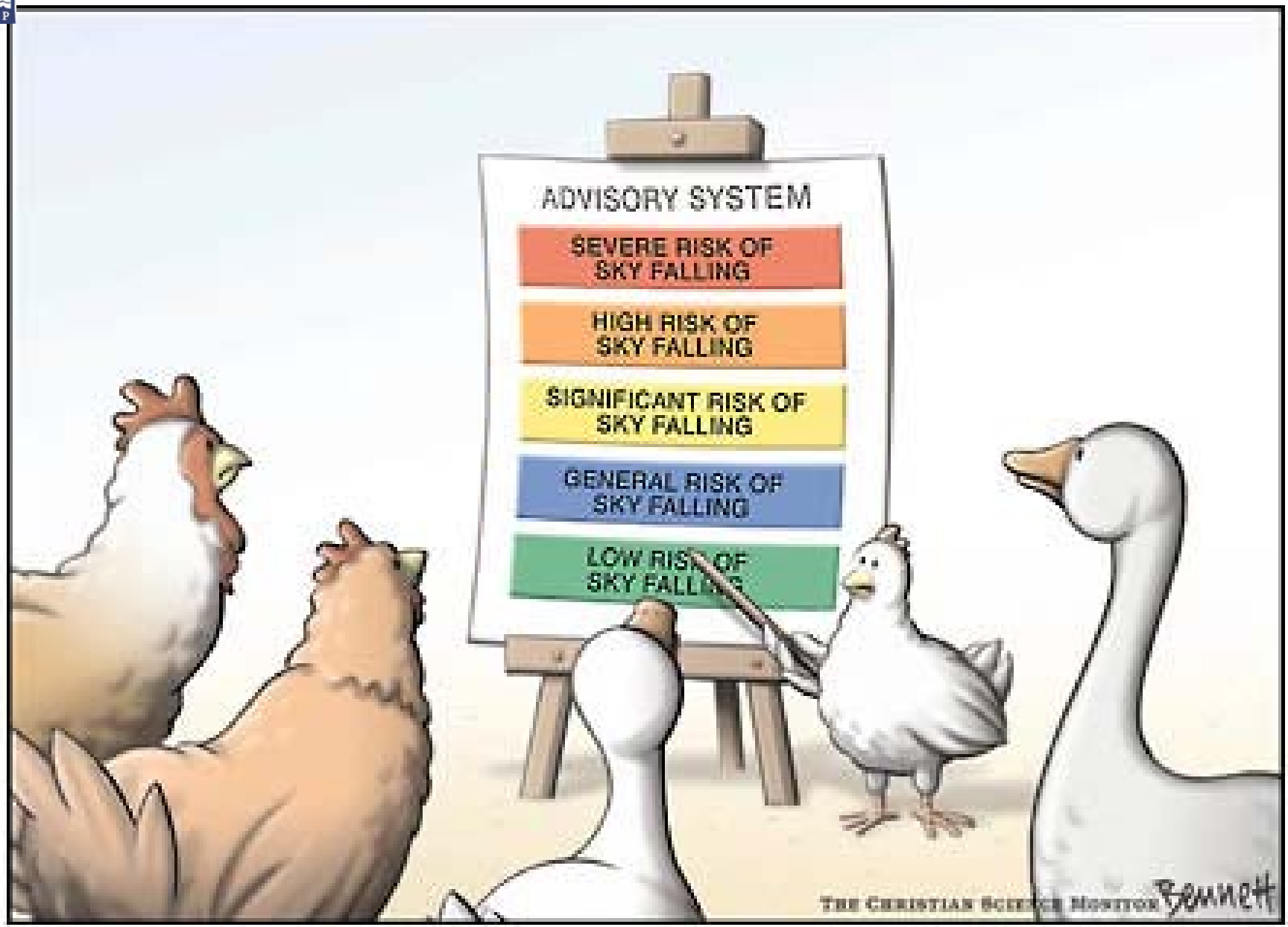
- Palmer, R.N. and Hahn, M.H. (2002). "The Impacts of Climate Change on Portland's Water Supply: An Investigation of Potential Hydrologic and Management Impacts on the Bull Run System." Prepared for the Portland Water Bureau.

Climate **and** Landcover Impacts on Snohomish Chinook Salmon

- Climate Change has a detrimental impact
- Restoration efforts appear likely to benefit salmon
- Good planning incorporates multiple variables simultaneously

GFDL A2 Climate Scenario




ADVISORY SYSTEM
SEVERE RISK OF SKY FALLING
HIGH RISK OF SKY FALLING
SIGNIFICANT RISK OF SKY FALLING
GENERAL RISK OF SKY FALLING
THE CHRISTIAN SCIENCE MONITOR
Bennett

Conclusions

- Are we doomed? **NO!**
- Do we need to plan for climate change? **Yes!**
- Climate change can further complicate existing resource allocation decisions
- Climate change is uncertain, but not so much that it is not possible to incorporate it into the planning process.
- Planning process already incorporates many large uncertainties.

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